

## EFFECTS OF COMPUTER - BASED TEST AND COMPUTER -ADAPTIVE TEST ON STUDENTS' PERFORMANCE IN PHYSICS IN OWERRI EDUCATION ZONE 1, IMO STATE

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### Abstract

The researchers investigated the effects of Computer Based Test (CBT) and Computerized Adaptive Test (CAT) on secondary school students' achievement in physics in Owerri of Imo State. To guide the study the researchers formulated three hypotheses. The study adopted a quasi-experimental research design involving pre-test, post-test, non-randomised intact class groups. The area of the study is Owerri Education Zone I of Imo State. The population of the study is 1638 SS2 students in two sampled schools. The sample for the study is 80 SS2 students sampled using simple random sampling techniques. The instruments for data collection are two physics performance tests (PAT). The first instrument is a PAT-Pre used as a pre-test and delivered through a paper and pencil test (PPT) method. The second instrument is still a PAT but was delivered in two test delivery formats (CBT and CAT). CBT contains 50 multiple choice test (MCT) items. At the same time, for the CAT, the researchers created a larger pool of test items (200 items) so that there is enough questions to match the varied abilities of all students taking the exam. The internal consistency coefficients of 0.74 and 0.80 were obtained using Kuder-Richardson 20 for PAT-Pre and PAT- Post respectively. Mean and standard deviation were used to answer the research questions while analysis of covariance (ANOVA) was to test the hypotheses at 0.05 alpha level of significance. The results of the study revealed that the difference in the mean performance scores of the students exposed to CBT and CAT is significant even beyond the set probability value of 0.05; the difference in the mean performance scores of students in physics is not significant; and there is no significant gender by treatment interaction effect of CBT and CAT. Based on the findings, the researchers recommend that both CAT and CBT be used to assess secondary school students' performance in physics.

**Keywords:** Computer Based Test (CBT), Computer-Adaptive Test (CAT), Students' Performance, Physics

### Introduction

Science is recognized widely as being of great importance locally and internationally for economic well- being and the need for scientifically literate citizenry (Ntukidem, 2004). Physics is one of the core science subjects studied at the

Senior Secondary School level as prescribed by the National Policy on Education. The curriculum is based on equipping Senior Secondary School graduates with basic knowledge and skills to appreciate the nature of physical problems in any society and adequately prepare them for the challenges in the Nigerian technological system. Weidner (2015) explains that physics is a science that deals with the structure of matter and the interaction between the fundamental constituents of the observable universe. Adeyemo (2010) stated that learning physics is difficult at best and almost impossible at worst. Still, because of its enormous importance to science and technology, there is understandably huge interest in students' performance in physics. The inevitable role of Physics in the nation's technological development is that government at all levels had incorporated the subject in the school curriculum through the research reports of bodies like; National Science and Technology Development Agency (NSTDA), Nigeria Education Research Council (NERC) and Science Teachers' Association of Nigeria (STAN) among others.

Physics is crucial for effective living in the modern age of science and technology. Physics is the study of natural occurrence phenomena at its most fundamental level (Olumuyiwa and Okunola 1992). Given its application in industry and many other professions, it is necessary that every student is given an opportunity to acquire some of its concepts, principles and skills. The general objectives of the physics curriculum according to Nigerian Educational Research and Development Council (NERDC) 2008, includes to:

1. Provide basic literacy in physics for functional living in the society;
2. Acquire basic concepts and principles of physics as a preparation for further studies;
3. Acquire essential scientific skills and attitudes as a preparation for technological application of physics; and
4. Stimulate and enhance creativity within the environment.

However, despite the relevance of physics to scientific and technological breakthrough of nations, the subject has been faced with myriad of problems in Nigeria. Some of the problems according to Usman (2011) include: poor performance of students, low enrolment, and gender disparity, lack of laboratory equipment and shortage of competent manpower. Some teachers lack accurate knowledge of physics subject matter and update knowledge (Imo, 2009). The West African Examination Council (WAEC) (2019) shows that physics still have low learning outcomes countrywide. Ogunleye in Usman (2011) highlighted some factors prevailing against students understanding and performance in secondary school physics to include; overloaded curriculum, uneven distribution of curriculum content, difficult nature of physics concepts, lack of competent physics teachers and non-functional physics curriculum, test formats used for the assessment of the students. It is probably in realization of how well the learners have attained the objectives of instruction, as well as in using such information for curriculum development that emphasis is laid on educational evaluation (Federal Republic of Nigeria, FRN, 2013). In an attempt to introduce a more realistic system of evaluation, the government directed that

educational assessment shall be liberalized by being based in whole or part on continuous assessment of the progress of the individual.

In general, assessment, in the form of a performance test, serves the purpose of identifying the learners' extent of mastery of knowledge and skills, contributes to effective teaching of a subject. This implies that performance test should guide the teaching process for enhanced learning to occur. This shows that test is important in the teaching and learning process. Iwuji (2010), defined a test as an instrument given at the end of a teaching-learning programme. The author explained that test is used to find out how much a student is able to achieve in a course he/she has been taught. Also Nwogu (2015) explained that test is a systematic and purposeful quantification of learning outcomes. It involves the determination of the degree of attainment of individuals on tasks, courses or programmes to which the individuals were exposed. Test is very important in education. Some tests are "verbal", where the test is given verbally, no pen or paper is needed to answer the questions while some other tests are written, that is a test where the pupils have to answer question using a pencil or pen, on paper. However, assessment method involving the whole or part of Information Communication Technology (ICT) is on the increase.

New assessment techniques that use ICTs provide students with a different modality of instruments. It creates room for individualized instructions. It helps students adjust to their attention span and provide valuable and immediate feedback for literacy enhancement (Eneku & Eneku, 2000). ICT application and use will prove beneficial in improving the educational system and giving students a better education. Moreover, the use of ICT tools in secondary schools has enhanced both the teaching and learning process and makes it easy for the performance of the teachers' set objectives. According to Barker (2002), ICT has proved to be a powerful tool in education reform. Based on this assertion, secondary schools in the last few years have been reviewing their mission, goals, strategies and operations to position themselves more effectively to meet the challenges of the 21st century.

Information Communication Technology (ICT) as a tool and a change agent in education helps to keep records, analyzes data that are useful in assessment. Successful assessment relies on ICT to facilitate the process. ICT helps teachers generate needed information (data) by using testing and non-testing techniques, then analyzing the data and finally making judgments and decisions. ICT also allows teachers to collect, record, organize and store students' responses. Common forms of ICT used for data collection include video cameras for observations, interviews, rating scales, questionnaires, portfolios, exhibitions, class discussions, students' self-assessments, projects, assignments and homework. Analyzing data and reporting the results of the students are key components of assessment. Teachers can use ICT such as statistical software's to analyze data collected from students to work out their results. Secondary schools as agents of development and custodians of societal technological transfer in Nigeria play key roles in the field of ICT. Much is expected from them in the application of new technologies in educational assessment. Two of the assessment methods that involve ICT and which are the trust of this study are Computer Based Test (CBT) and Computerized adaptive test (CAT).

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A solution of examination in large classes of students is an automated testing system which has not yet been fully introduced by institutions in the country, primarily to address this concern and others. Computer-Based Testing (CBT), also known as Computer- Based Assessment or e-assessment/testing has been available in various forms for more than four decades (Sorana- Daniela & Lorentz, 2007). Over the years, CBT has grown from its initial focus on certification testing for the IT industry, to a widely accepted delivery model serving elements of virtually every market that was once dominated by Paper-and- Pencil Testing (PPT) (Abubakar and Adebayo, 2014; Alabi, et al., 2012). It is a method of administering tests in which the responses are electronically recorded, assessed, or both. It is commonly available for several admission tests throughout the developed countries (Oduntan, Ojuawo & Oduntan, 2015). Computer-based testing or computer-based assessment is a green computing (green IT) strategy used to reduce paper consumption (Peter *et al.*, 2004). Computer-based tests offer several benefits over paper-and-pencil or paper- based tests (Oduntan, Ojuawo & Oduntan, 2015).

Technology- based assessment, such as CBT, provides opportunities to measure the complex form of knowledge and reasoning that is impossible to engage and assess through paper and pencil method (Bodmann and Robinson, 2004). Generally, advantages of CBT systems over paper-and-pencil testing (PT) have been demonstrated in several comparative works and as mentioned by (Peter et al., 2004) CBT is not just an alternative method for delivering examinations, it represents an important qualitative shift away from traditional methods such as paper-based tests. Today, in Nigeria, Joint Admission Matriculation Board (JAMB) has introduced a computer-based test for admission into tertiary institutions. The first CBT conducted by JAMB was in 2013 of the Unified Tertiary Matriculation Examination (UTME). The objective of the e-testing was to ensure 100% elimination in Nigeria which has been part and parcel of paper and pen tests. JAMB this year has fully inaugurated and implemented the CBT for students seeking admission to the Nigerian's tertiary institution. Some tertiary institutions adopted CBT in the Post Unified Tertiary Matriculation Examination (PUTME). For example, the University of Port Harcourt started their CBT examination precisely in 2011, the University of Jos in 2009 and the University of Uyo in 2006. Other institutions such as the University of Ilorin, Federal University of Technology Akure and the Federal University of Technology Minna maximize the use of CBT as tools for undergraduate and postgraduate assessments (Abubakar & Adebayo, 2014).

Computer-adaptive testing (CAT) has emerged as a viable option for universal screening. These tests refines the selection of items based on a student's response and help teachers diagnose students' areas or strength and weaknesses (Shapiro & Gebhardt, 2012). Examples of this kind of test include the NWEA and STAR assessment. CATs are a formative way of collecting data and help teachers adjust their instructional decisions based on the data they receive. Computerized adaptive testing (CAT) solves these problems by selecting items that directly target each student's observed level of ability. An effective CAT can quickly identify and administer items

that are the most informative at a particular ability level, and each CAT is specifically matched to the test taker. This is achieved by first asking a student a question at a moderate difficulty level, and then if the student answers this question correctly, the next question is more difficult. If that question is answered incorrectly, then the next question is easier. This pattern continues until the computer can estimate the proficiency of the examinee based on a predetermined level of accuracy (Wainer, 2000). This results in a much more efficient testing environment and one that yields much more precise measurement information, and may allow one to administer a shorter test (Davey & Pitoniak, 2006; Way, Davis, & Fitzpatrick, 2006; Wainer, 2000). There are two basic types of CAT: Fixed length: each examinee sees the same number of items. These tests more closely mirror a more traditional test as examinees who are best targeted by the items in the test, are measured more precisely than students who are less well-targeted by the items in the pool. And Variable length: these tests keep serving up items to examinees until a pre-determined level of precision is achieved—examples of variable length CATs are the NCLEX and GRE.

Critical to adaptive testing is the fact that if the underlying algorithms are working correctly, then students see questions which are targeted to their skill and knowledge level. One would expect students to get about half of the questions correct—regardless of ability. Higher-ability students should get about half of a more difficult set of questions correct, and the lower-ability students about half of a less difficult set of questions correct. In either case, the percentage alone is not informative when looking at student proficiency. A score on an adaptive test depends both on how many questions the student answered correctly and the difficulty of the items. And the difficulty of the items can only be predetermined if there is a pilot testing period during which data on items is collected (the section on IRT below expands on these ideas).

Previous research showed that more people anticipated problems with the computer assisted assessment than actually had them (Erle et al., 2006). Their research also showed that despite fewer students being confident about CBT before completing the assessment more students preferred CBT afterwards. Previous study conducted indicated a preference for CBT over PPT (Fyfe et al., 2005). Some studies reported the main disadvantage as being increased anxiety amongst those unfamiliar with use of computer (Erle et al., 2006) and as such students agreed that they are “technophobic”. The challenge to test examinees by means of microcomputers demands appropriate software design. The results of the effect of demographic attributes on students' CBT performance are not always consistent. For example, some studies indicate that gender was not related to performance differences between CBT and PPT (Clariana & Wallance, 2002; Alexander et al., 2001), while other studies suggest that gender is associated with the test mode (Leeson, 2006; Gallagher et al., 2000), with male examinees benefiting from the CBT format more than female examinees who showed slightly poorer performance on CBTs. The study by Alexander et al. (2001) suggests no difference in the administration mode for age and class level. Consistent results were found in examinees' race associated with the test

mode (Gallagher et al., 2000; Parshall & Kromrey, 1993). It was found that although the differences were quite small, some patterns were consistently found for some racial/ethnic groups, with African American examinees and Hispanic examinees benefiting from the CBT format (Gallagher et al., 2000). To explore whether family income was related to testing mode effect, Pomplun and Custer (2005) examined the differences between format score means at grade level from K-3 for students eligible for free/reduced lunch and students not eligible for free/reduced lunch. Results showed that at every grade, the free/reduced lunch eligible students had larger score differences in favor of the PPT than for students not eligible for free/reduced lunch. In addition, these differences generally decreased as grade level increased, suggesting that family income and possibly computer familiarity may be related to PPT/CBT score differences and that the longer students are in school and exposed to computers, the smaller the score differences become.

Chua (2012) compared Paper-and-Pencil Testing (PPT) to Computer-Based Testing (CBT) at a university level. One hundred forty participants (68 males; 72 females) enrolled in a Malaysian teacher education program were randomly assigned to one of four groups: two treatment groups and two control groups. The treatment groups were given Computer Based pre-tests and post-test; The control group were administered the same tests in the paper-based versions. The results show that CBT was a more reliable measure, reduced time spent taking a test, and increased self-efficacy. In spite of Nigerian government's desire to promote science education programme in the country, the quality of science students produced by the secondary schools seem to be deteriorating. In the particular case of Physics, one is led to observe that despite the importance of Physics as a science subject, evidence have shown that students are not doing well in this subject at both West African Secondary School Certificate Examination (WASSCE) and National Examination Councils' Secondary School Certificate Examination (NECOSSCE). Consequently, there is need to empirically identify things that can enhance students' performance secondary school Physics. Therefore, the problem of this study put in a question form is: Is there a test type that can improve or enhance students' performance in Physics? Specifically, does significant differences exist between students' performance in Physics when exposed to computer based test (CBT) and computerized adaptive test (CAT)?

Generally, this study is aimed at investigating the effects of Computer Based Test (CBT) and Computerized Adaptive Test (CAT) on secondary school students' performance in physics in Owerri Education Zone 1, Imo State.

Specifically, the study sought to;

1. ascertain the mean performance in physics of secondary school students exposed to CBT and CAT in Owerri Education Zone 1;
2. ascertain the mean performance in physics of male and female secondary school students exposed to CBT and CAT in Owerri Education Zone 1; and
3. determine the gender by treatment interaction effects of CBT and CAT.

### **Research Hypotheses**

The following null hypotheses were formulated and tested at 0.05 alpha level.

1. The mean performance in physics of secondary school students exposed to CBT and CAT in Owerri Education Zone 1 do not differ significantly.
2. The mean performance in physics of male and female secondary school students exposed to CBT and CAT in Owerri Education Zone 1 do not differ significantly.
3. There is no significant interaction effect of gender and treatment on CBT and CAT.

### **Methodology**

The researchers adopted a quasi-experimental research design, which involves intact groups, pre-test, post-test, non-randomization. A quasi-experimental design was adopted because there were no randomization, the students were sampled in their respective schools and classes using simple random sampling techniques. The study involves two treatment groups (Computer Based Test and Computerized Adaptive Test groups). According to Cohen, Manion and Morrison (2007), a quasi-experimental research design is the type of design employed in true experimental research, where the random selection or random assignment of subjects (students) is quit impracticable. The area of the study is Owerri Education Zone I of Imo State. The population of the study is all the 1,638 SS2 Physics students in Owerri Education Zone 1 (Statistical Unit Secondary Education Board (SEMB) Owerri, 2020/2021). The sample for the study is 80, comprising of 42 female and 38 male SS2 students offering physics in two sampled secondary schools. The simple random sampling technique (balloting) was used to sample two secondary schools. The instruments for data collection are two physics performance tests (PAT). The first instrument is a PAT-Pre used as a pre-test and delivered through a paper and pencil test (PPT) method. The purpose of this test (pre-test) was to get the baseline data or the initial performance scores of the students that constitute the covariate values for ANOVA. The second instrument is still a PAT but with items different from PAT-Pre. This test was delivered in two test delivery formats (CBT and CAT). CBT contains 50 multiple choice test (MCT) items. For the CAT the researchers created a larger pool of test items (200 items) so that there is enough questions to match the varied abilities of all students taking the exam. Both CBT and CAT items have four option of A to D. The students were required to select only one option. The internal consistency coefficients of 0.74 and 0.80 were obtained for PAT-Pre and PAT respectively using Kuder-Richardson formula twenty. Mean and standard deviation were used to answer the research questions while analysis of covariance (ANCOVA) was to test the hypotheses at 0.05 alpha level of significance.

### **Results**

**Hypothesis One:** What are the mean performance in physics of secondary school students exposed to CBT and CAT in Owerri Education Zone 1?

**Table 1** Group Size (n), Mean ( $\bar{x}$ ) and Standard Deviation (S.D) of Scores of Students exposed to Computer Based Test (CBT) and Computerized Adaptive Test (CAT)

Group	n	Pre-test		Post-test	
		$\bar{X}$	S. D	$\bar{X}$	S. D
CBT	47	15.64	3.14	32.13	5.36
CAT	43	16.16	3.42	35.23	5.25

From Table 1, the mean performance scores of the students exposed to the CBT and CAT in the pre-test are 15.64 and 16.16 respectively. Their respective standard deviations are 3.14 and 3.42. On the other hand, in the post-treatment test the mean performance scores in physics of secondary school students exposed to CBT and CAT are 32.14 and 35.23 respectively. Their respective standard deviations are 5.36 and 5.25.

**Table 2**  
ANCOVA Summary Table Tests of Between - Subjects Effects

Source	Type III Sum of Squares <sup>a</sup>	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	288.805 <sup>a</sup>	4	72.201	2.554	.045	.107
Intercept	2993.140	1	2993.140	105.893	.000	.555
Pretest	68.895	1	68.895	2.437	.122	.028
Treatment	191.379	1	191.379	6.771	.011	.074
Gender	1.136	1	1.136	.040	.842	.000
Treatment * Gender	4.835	1	4.835	.171	.680	.002
Error	2402.584	85	28.266			
Total	104365.000	90				
Corrected Total	2691.389	89				

a. R Squared = .107 (Adjusted R Squared = .065)

Table 2 showed that the calculated F-ratio of 6.771 is greater than the critical F-ratio of 3.92. Also, the p-value of 0.011 is less than the alpha level of 0.05. Based on the results, null hypothesis one is rejected. Therefore, the mean performance in physics of secondary school students exposed to CBT and CAT in Owerri Education Zone 1 differ significantly.

**Hypothesis Two:** The mean performance in physics of male and female secondary school students exposed to CBT and CAT in Owerri Education Zone 1 do not differ significantly.



**Table 3** Mean (  $\bar{x}$  ) and Standard Deviation ( S.D ) of Scores of Male and Female Students exposed to Computer Based Test (CBT) and Computerized Adaptive Test (CAT)

Group	Male			Female		
	n	$\bar{X}$	S.D	n	$\bar{X}$	S.D
CBT	24	31.92	5.52	23	32.35	5.29
CAT	23	35.39	5.70	20	35.05	4.81

From Table 3, the mean performance scores of male students exposed to physics CBT and CAT are 31.92 and 35.39. Their respective standard deviations are 5.52 and 5.70. For the female students, the mean performance scores for those in CBT and CAT groups are 32.35 and 35.05 respectively. Their respective standard deviations are 5.29 and 4.81. The results showed that the mean performance score of male students exposed to CAT is greater than the mean performance score of the male students exposed to CBT. Also, the mean performance score of female students exposed to CAT is higher than that of female students exposed CBT. Similarly, the mean performance score of male students in CBT group is slightly higher than that of their female counterparts in the same group. In the CAT group, the mean performance score of the female students is slightly higher than that of their male counterparts exposed to the same treatment.

**Table 4**

Summary ANCOVA F-ratio Table for Testing Hypothesis Two

MS	df <sub>1</sub>	df <sub>2</sub>	f <sub>cal</sub>	p-value	F <sub>crit</sub>	$\eta^2$	Decision
1.13	61	85	0.040	0.842	3.92	0.00	H <sub>02</sub> is accepted

**Extracted from Table 2**

In Table 4 the calculated F-ratio of 0.040 is less than the critical F-ratio of 3.92, while the p-value of 0.842 is greater than the significance value of 0.05. Thus, the null hypothesis two is accepted. Therefore, the mean performance in physics of male and female secondary school students exposed to CBT and CAT in Owerri Education Zone 1 do not differ significantly.

**Hypothesis Three:** There is no significant gender by treatment interaction effects of CBT and CAT.

**Table 5**

Summary ANCOVA F-ratio Table for Testing Hypothesis Two

MS	df <sub>1</sub>	df <sub>2</sub>	f <sub>cat</sub>	p-value	F <sub>crit</sub>	$\eta^2$	Decision
4.83	51	85	0.171	0.680	3.92		H <sub>02</sub> is accepted

**Extracted from Table 2**

Table 5 shows that the calculated F-ratio of 0.171 is less than the critical F-ratio of 3.92. Also, the p-value is greater than the set probability value of 0.05. The null hypothesis three is, therefore, accepted. Hence, there is no significant gender by treatment interaction effects of CBT and CAT.

**Discussion of Findings**

The result of the study revealed that the mean performance score of students exposed to CAT is higher than the mean performance score of the students exposed to CBT. The statistical test carried out shows that the difference in the mean performance scores of the students exposed to CBT and CAT is significant even beyond the set probability value of 0.05. This finding shows that even though students' mean performance scores in the two groups are above the average score of 25, the students exposed to CAT performed significantly higher than their counterparts exposed to CBT. One possible explanation for the effect of CAT over CBT could be because in adaptive tests, the level of difficulty in the tests adapts to the performance of the candidate. The candidate gets a harder or easier item following a correct or incorrect answer respectively. Okoli, Ubangha and Egberongbe (2018) found the performance of students exposed to CBT to be significantly higher.

The result statistical test of hypothesis revealed that the difference in the mean performance scores of students in physics is not significant. This shows that the gender of the students did not influence their performance in physics. Aina and Akintunde (2013) found that male students performed significantly better than female. Another result of the study revealed that there is no significant gender by treatment interaction effect of CBT and CAT. This shows gender of the students did not significantly influence how much they benefited from the two treatments (CBT and CAT).

**Conclusion**

Computerized Adaptive Test (CAT) improved students' performance in physics significantly better than Computer Based Test (CBT). Students' performance in physics did not significantly differ. Also, both CAT and CBT are not gender biased. That means both male and female students benefited equally from the two test delivery formats.

**Recommendations**

Based on the findings of the study the following recommendations were made.

1. Both CAT and CBT can be used as alternatives to assess secondary school students'

performance in physics. However, CAT improved students' performance more, probably due to its adaptive nature.

2. Both male and female students should be encouraged to enroll in physics in secondary schools, since students' performance in physics does not depend on their gender.
3. Teachers and other test users can use both CAT and CBT to assess students' performance in physics irrespective of their gender.

## References

- Abubakar, S. A. & Adebayo, O. F. (2014). Using computer based test method for the conduct of examination in Nigeria: Prospects, challenges and strategies. *Mediterranean Journal of Social Sciences*, 5 (2), 47-55.
- Adeyemo, J.D. (2010). Availability and utilization of resources for teaching junior secondary school studies in kwara state, Nigeria. An unpublished M.Ed. Thesis University of Illorin, Illorin.
- Alabi, A. T., Isaa, A. O., & Oyekunle R. A. (2012). The Use of Computer Based Testing Method for the Conduct of Examinations at the University of Ilorin, *International Journal of Learning & Development*, 2(3), 2164-4063.
- Ames, A. N. (2003). The trend toward computer and computer anxiety is structural and causal. *Journal of Faculty of Education, University of Banha, Egypt*, 19, 191-164.
- Bennett, R. E., Jenkins, F., Persky, H., & Weiss, A. (2008). Assessing complex problem-solving performances. *Assessment in Education*, 10, 347-359.
- Bodmann, S. M. and Robinson, D. H. (2004). Speed and Performance Differences among Computer Based and Paper Pencil Tests. *Journal of Educational Computing Research*, 31(1), 51 – 60.
- Cuban, L. (2000). *Oversold and underused: computers in the classroom*. Cambridge, MA: Harvard University Press.
- Davey, T., & Pitoniak, M. J. (2006). Designing computerized adaptive tests. In S.M. Downing & T. M. Haladyna (Eds.), *Handbook of test development*. New Jersey: Lawrence Erlbaum Associates.
- DeRosa, J. (2007) The Green PDF: Reducing Greenhouse Gas Emissions One Ream at a Time. <http://www.scribd.com/doc/60779195/The-Green-PDF>.
- Duru, V.N. (2011). *Curriculum Studies: Concepts Development and Implementation*. Owerri: Avan Global Publications.
- Enuku, U.A., & Enuku, O. (2000) Breaking down the walls: Computer application in correctional/prison education. *Benin Journal of Educational Studies*, 1(2), 64- 71.
- Federal Republic of Nigeria (2013). *National Policy on Education 4<sup>th</sup> edition*. Lagos: NERDC Press.
- Fyfe G, Meyer J, Fyfe S, Ziman M, Sanders K, Hill J(2005). Self-evaluation of assessment performance can enhance student's perception of feedback on

- computer-generated tests. Conference: Proceedings of the 35th International Association for Educational Assessment Annual Conference, Brisbane, Australia.
- Gallagher, A., Bridgeman, B., & Cahalan, C. (2000). The effect of computer based tests on racial/ethnic, gender, and language groups (GRE Professional Board Report 96-21P, ETS RR-00-08). Princeton, NJ: ETS. Retrieved August 5, 2003, from [ftp://ftp.ets.org/pub/gre/gre\\_96-21p.pdf](ftp://ftp.ets.org/pub/gre/gre_96-21p.pdf)
- Iwuji, V. B. C. (2010). *Measurement and evaluation for effective teaching and learning*. Owerri: JeoMankpas Prints.
- Johnson M, Green S (2004). On-line assessment: the impact of mode on students' strategies, perceptions and behaviours. Paper presented at British Educational Research Association Annual Conference, Manchester, September 2004.
- Minnesota Pollution Control Agency, <http://156.98.19.245/paper/>, 2011.
- Ntukidem, N. O. (2004). Constraint to effective instructional standard in programmes of business education in tertiary institution. *Business Education Journal*, 4(2), 34- 42.
- Nworgu, B. G. (2015). *Educational Measurement and Evaluation: Theory and Practice*. Nsukka: Hallman Publishers.
- Oduntan, O.E., Ojuawo, O.O. & Oduntan, E.A. (2015). A comparative analysis of student performance in Paper Pencil Test (PPT) and Computer Based Test (CBT) Examination System. *Research Journal of Educational Studies and Review*, 1(1), 24-29.
- Oliver, R. (2011). *The role of ICT in higher education: ICT as a change agent for education*. (Accessed August, 2011).
- Oriaifor, S.O. (2002). *Refocusing tertiary education in Nigeria*. Benin City: Da-Sylva Influence.
- Peter, C., Bill, I. and David, S. (2004). Using computers for Assessment in medicine. *British Medical Journal*, 329 (7466), 606-609.
- Shapiro, E. S., & Gebhardt, S. N. (2012). Comparing computer-adaptive and curriculum-based measurement methods of assessment. *School Psychology Review*, 41(3), 295-305.
- Sorana-Daniela, B., and Lorentz, J. (2007). Computer-based testing on physical chemistry topic: A case study. *Inter. J. Educational Development using Information. Communication. Technology*, 3(1), 94-95.
- Wainer H, Dorans NJ (2000). Computerized adaptive testing: a primer. New Jersey: Lawrence Erlbaum Associates. USA. Williams B (2007). Students' perception of pre-hospital web-based examinations. *Inter. J. Educ. Develop. Infor. Commun. Technol.*, 3(1): 54-63.
- Wang, S., Young, M. J (2006). A meta-analysis of testing mode effects in Grade K–12 mathematics tests. *Educational and Psychological Measurement*, 67, 219-238.
- Weidner, H. (2015). *Computerized adaptive testing: a primer*. New Jersey: Lawrence Erlbaum Associates. USA.